OBLIQUE-WING GLIDE-BACK BOOSTER

FOR

SHUTTLE REUSABLE FIRST STAGE

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Background and Motivation

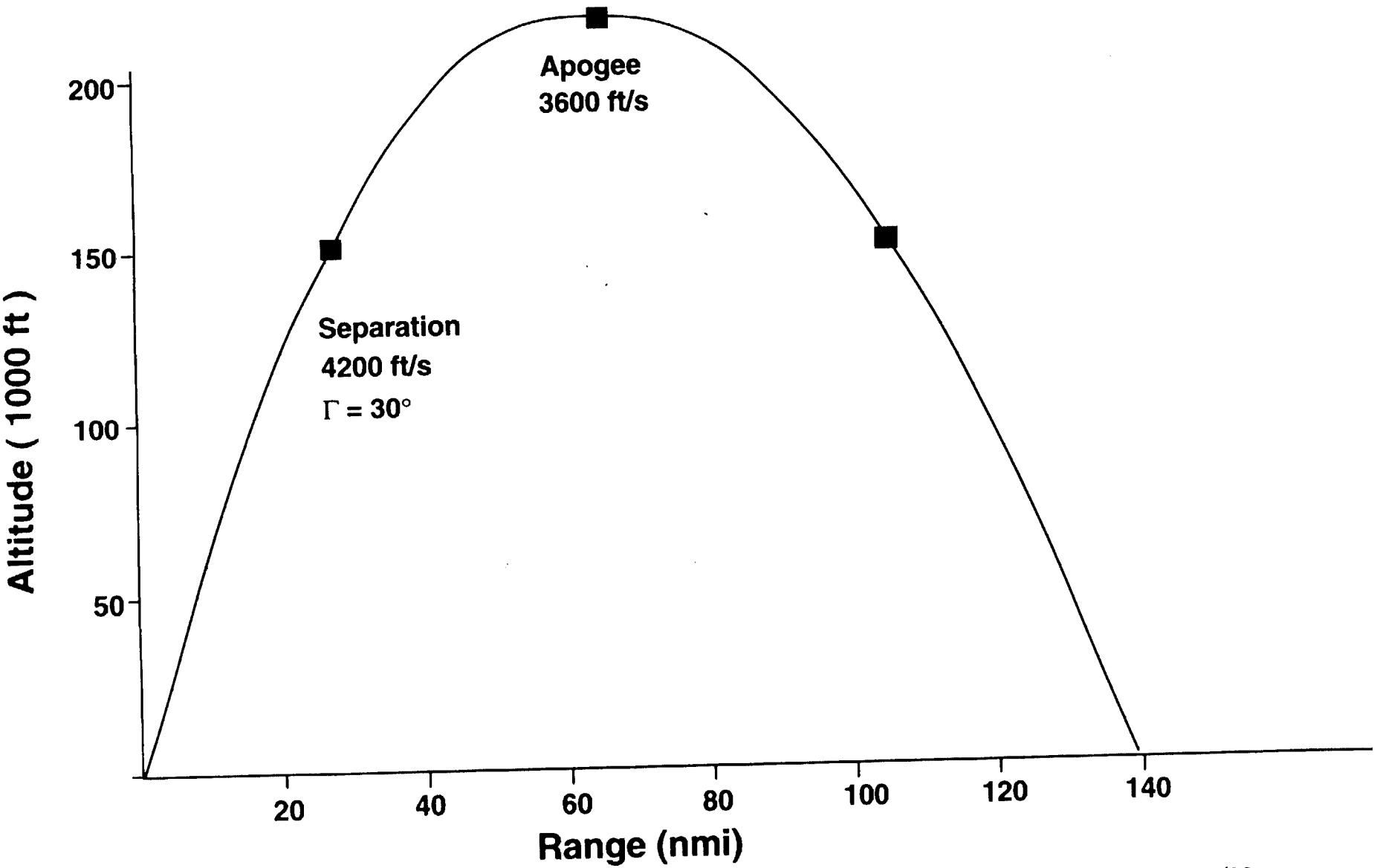
- Current Shuttle SRB Falls in Ocean After Separation
- Any Fly-back Concept Eliminates Search/Recovery Cost And Reduces Processing Cost
- Most Fly-back Concepts Require Engine, Fuel To Return
  Fuel Wt Approx 30,000 Lb/Booster
- Glide-back Concept Offers Much Lower Weight, Lower Complexity

Can It Be Done?

Objective:

- Demonstrate Feasibility of Turn and Glide-Back Using Oblique Wing Deployed on Reusable First Stage

Ballistic Trajectory of Current Shuttle SRB



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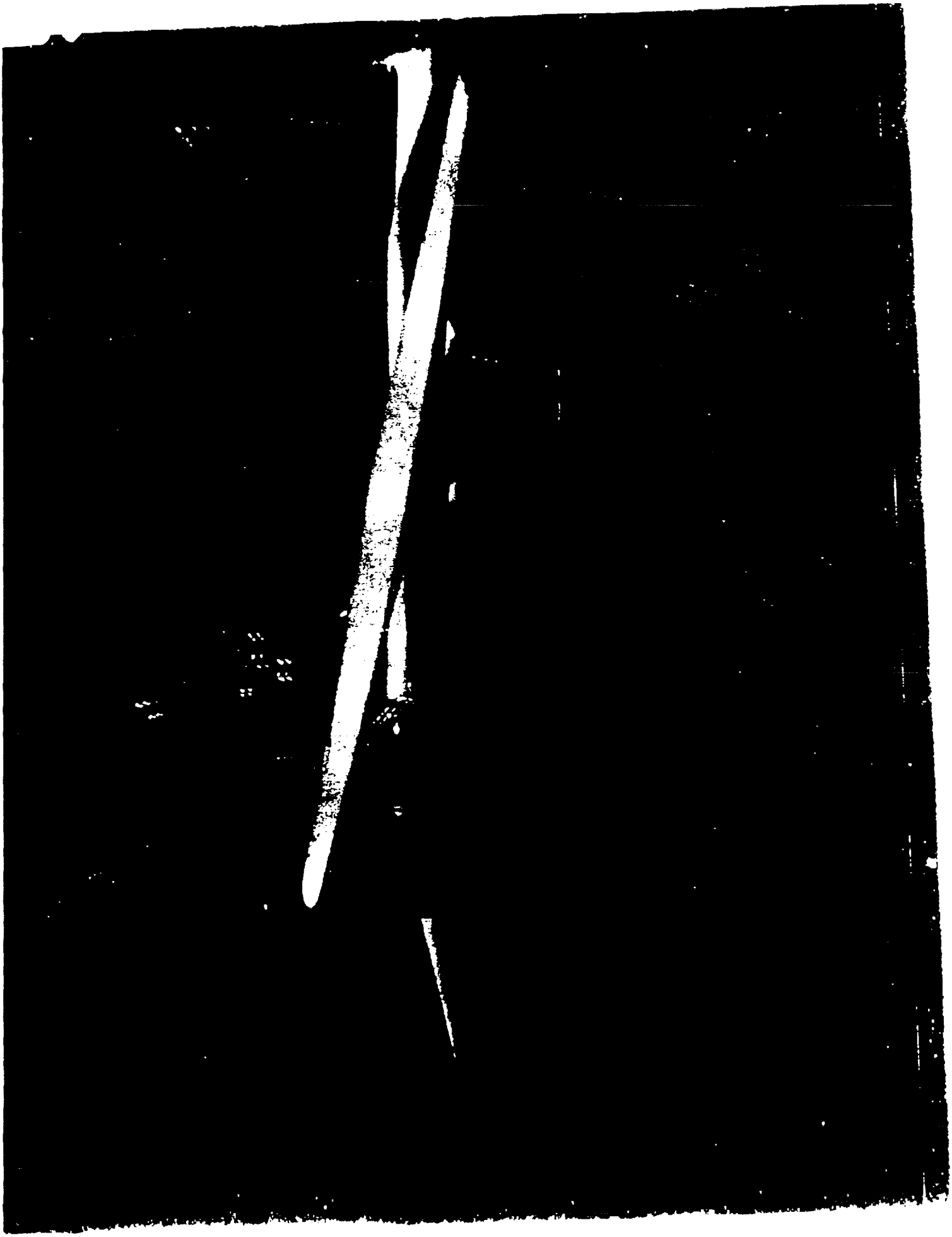
The Oblique-Wing Glide Back Concept

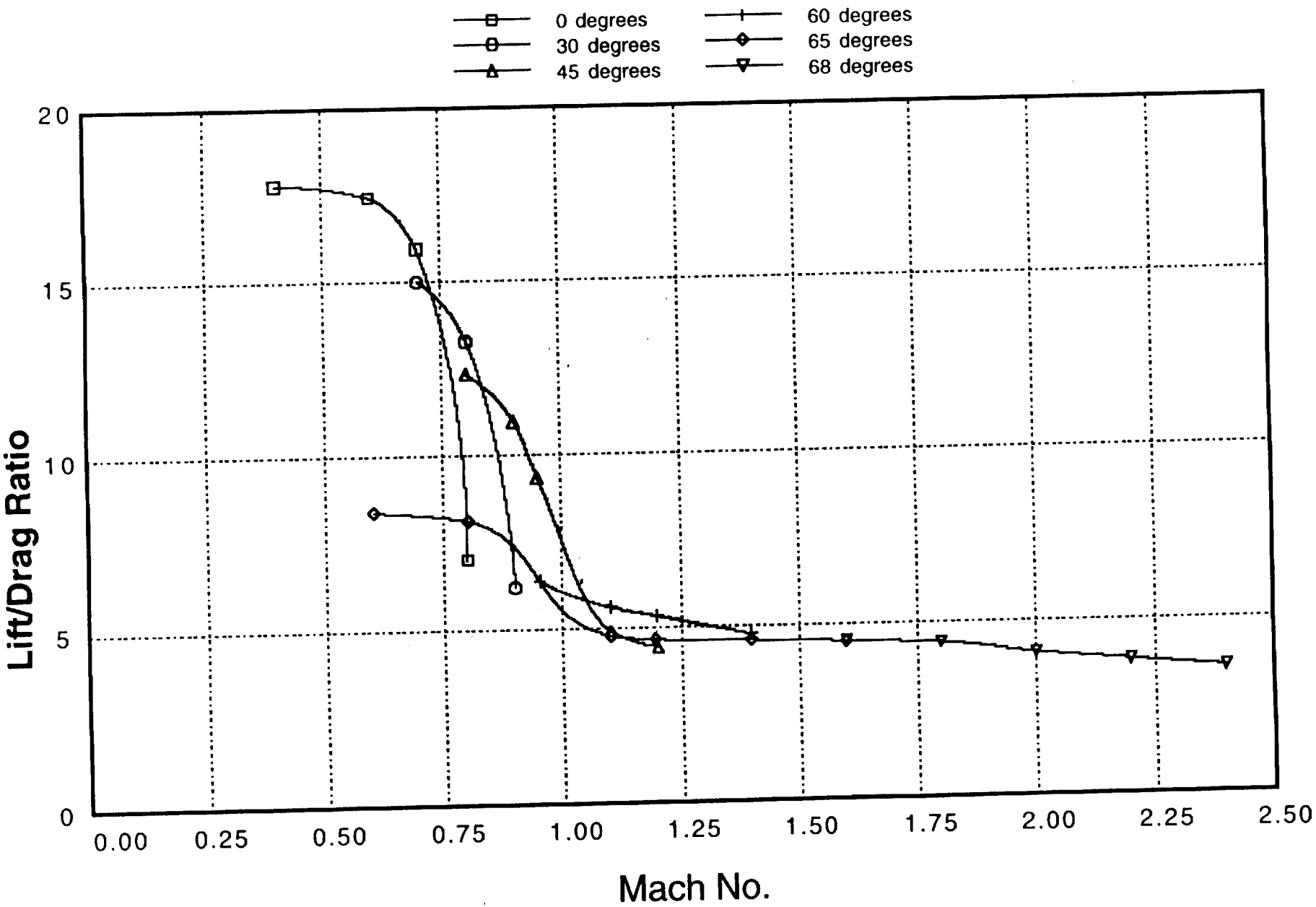
- Oblique Wing Stows with Minimal Impact on Ascent Configuration
- Variable Sweep, High Aspect-ratio Wing Provides Very High L/D Over Wide Mach No. Range
- Minimum Weight For Variable Geometry
  - Continuous Spar, No Bending In Pivot

Conceptual Design Sizing, Layout

- Wing Sized to Fit Existing Shuttle SRB
  - Biggest Wing Gives Best Turn Performance, Min Landing Speed
  - Nominal SRB Weight, Trajectory Used for Initial Feasibility Study
- Adaptable to Liquid-Fueled Booster, Aft C.G. Issue



Variable Sweep Provides High Aerodynamic Efficiency Over Wide Mach Number Range



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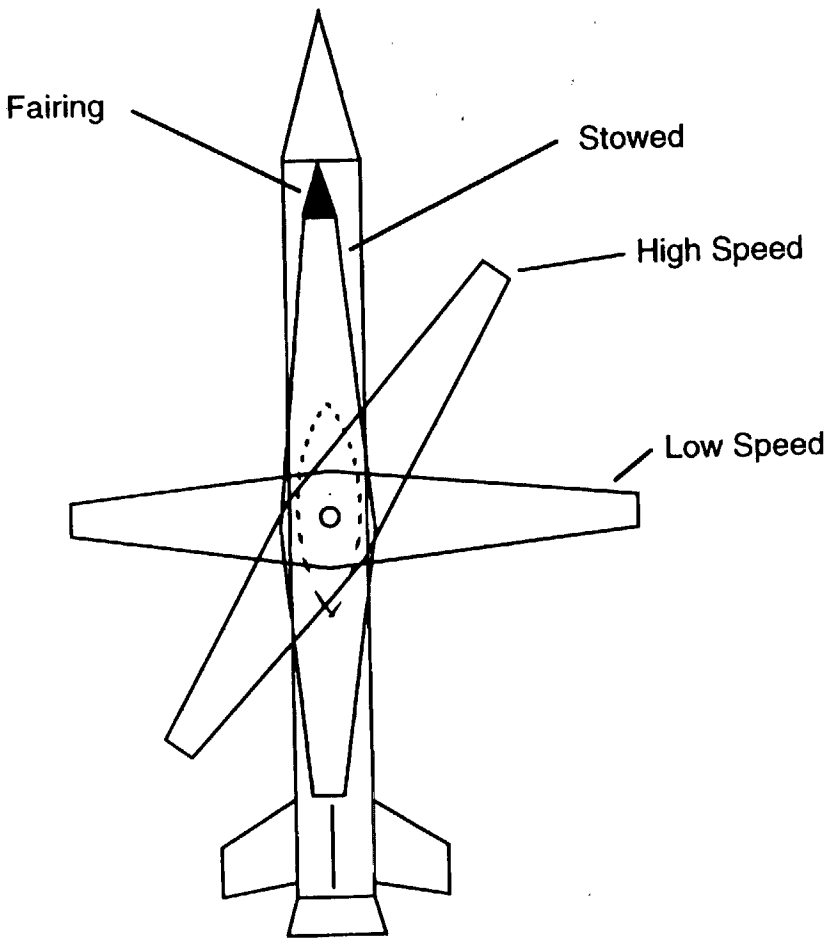
geometry figure — To be improved —



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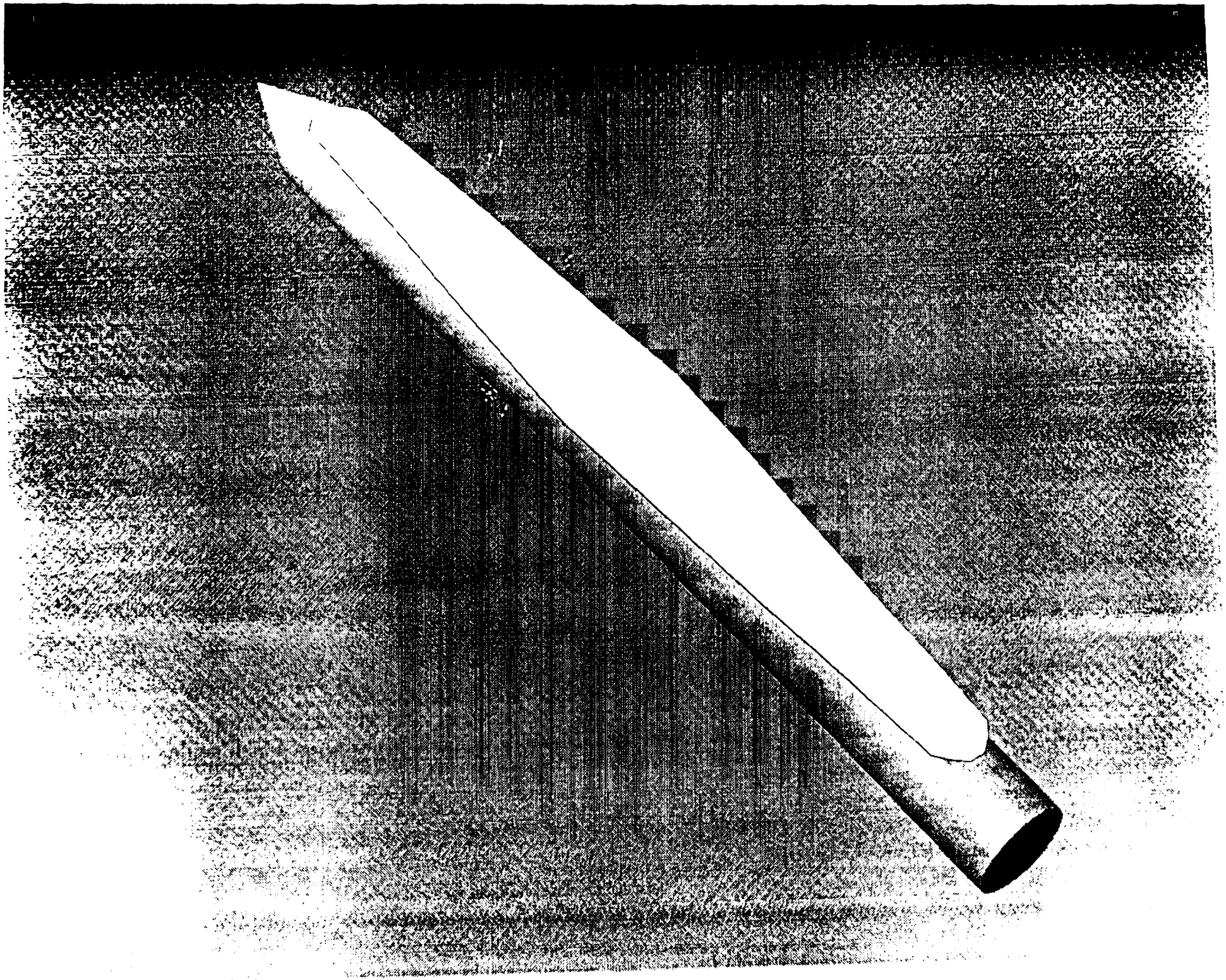

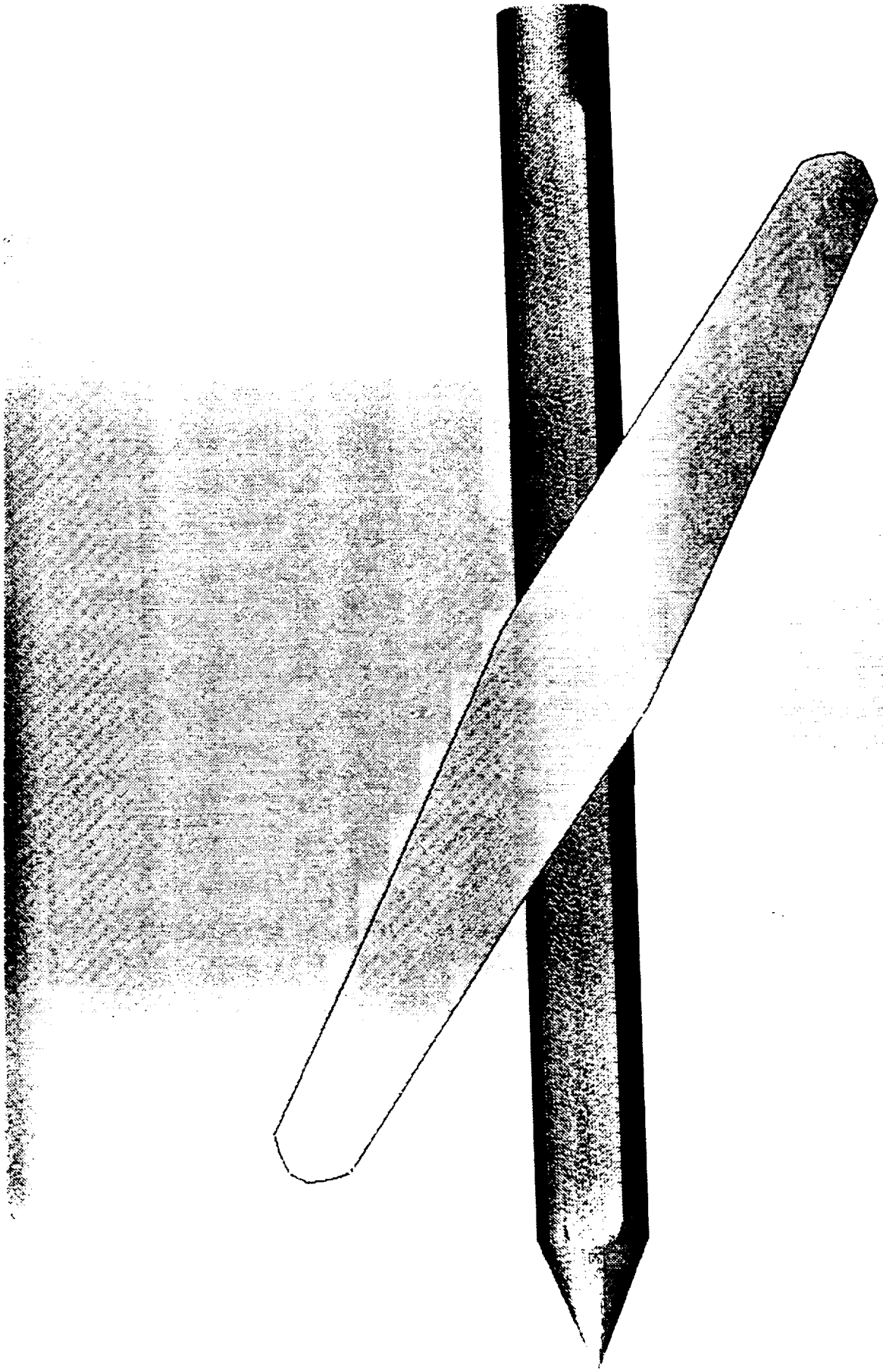

Trajectory Simulation of Turn and Glide-back Requires Aero-Performance Model

- Typcial Conceptual Design Studies Rely on Low-Fidelity Aero-Performance: CLmax, CD Estimation
- Extensive Wind Tunnel Database on Representative Configuration Provides High-Credibility Aero Model
- Data for Mach 0.4 - 2.5 From F-8 Oblique Wing Development
- Stowed Geometry Aero Model From CFD

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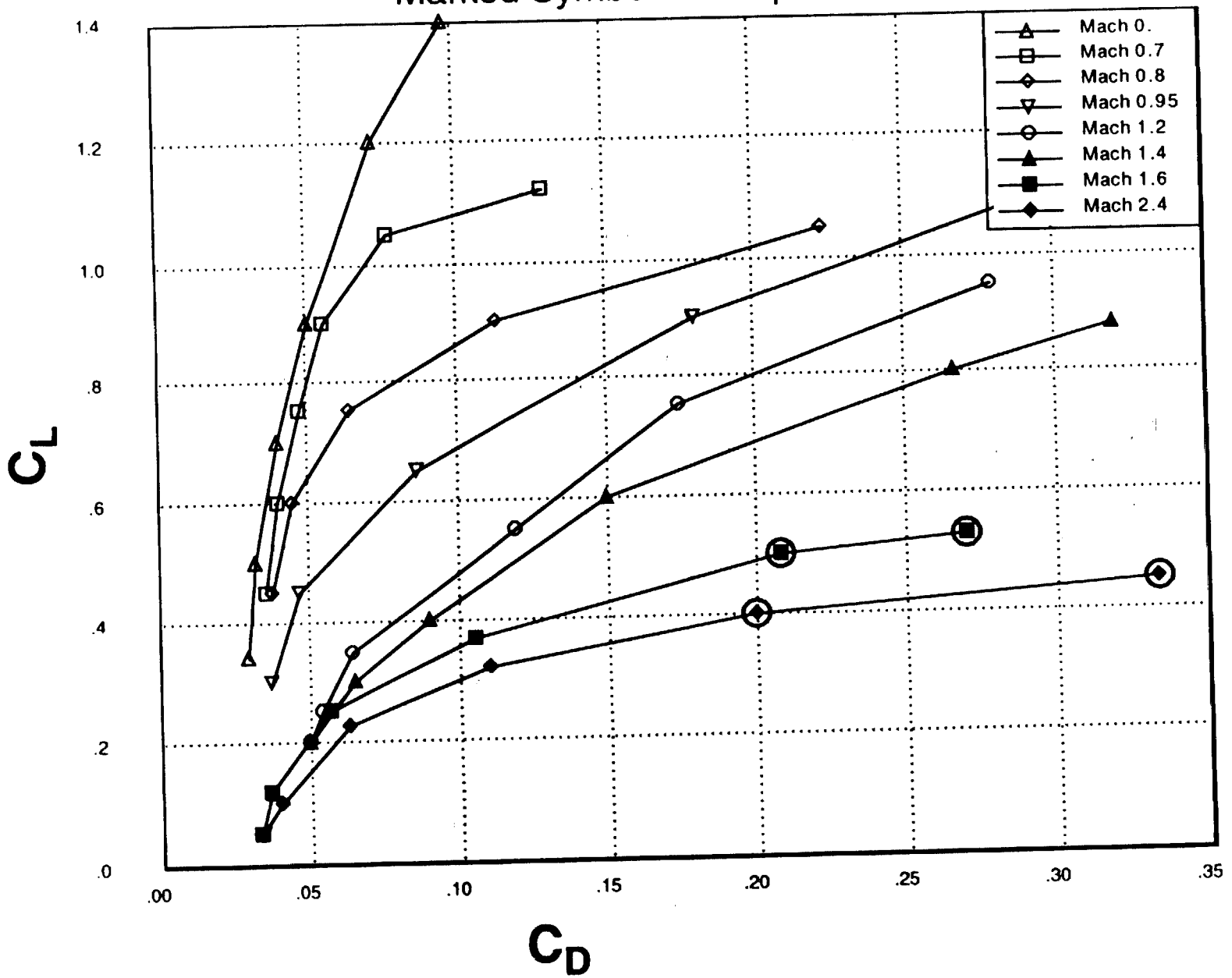
F-8 Wind Tunnel Data

Marked Symbols Extrapolated



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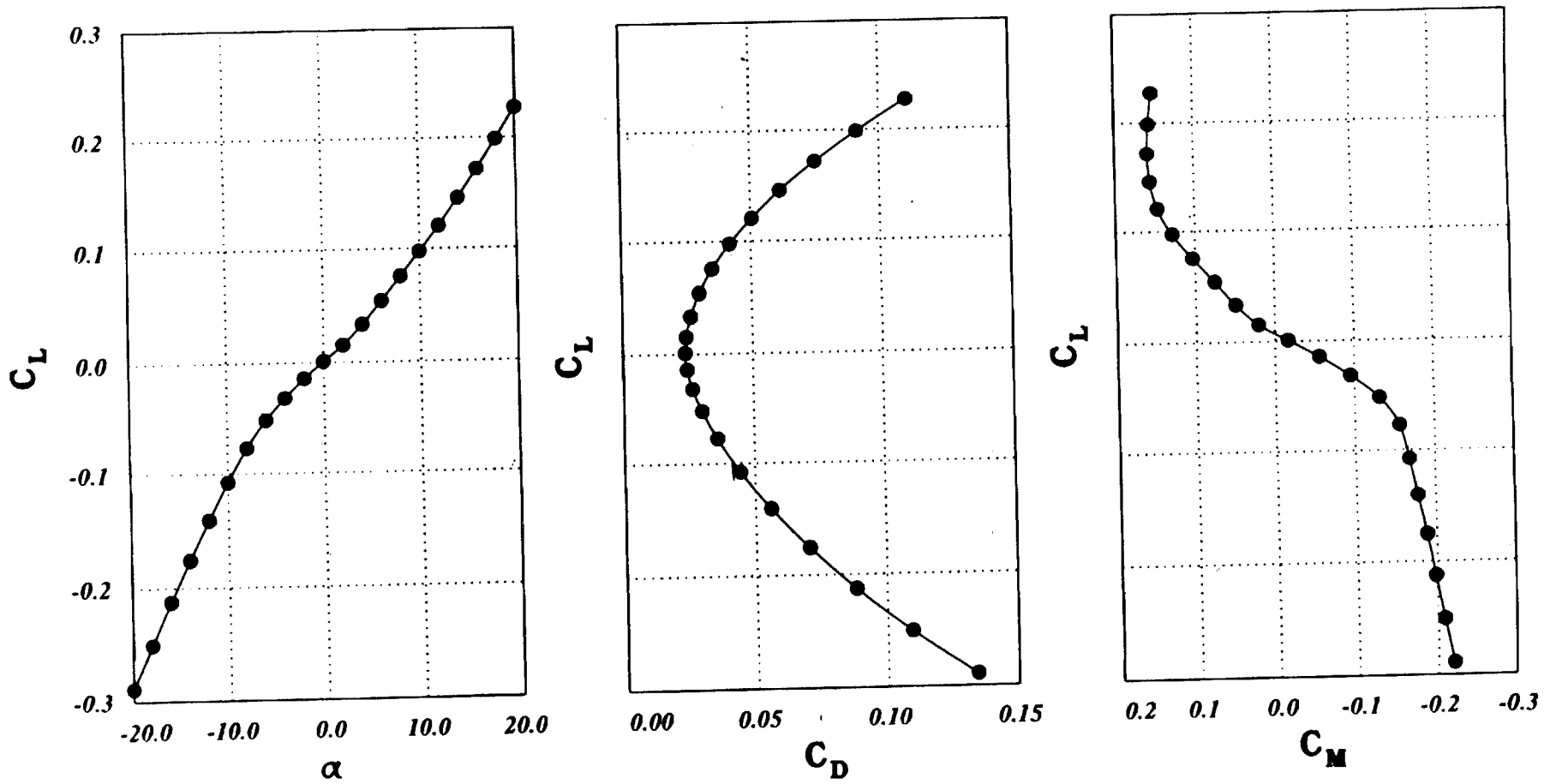
Stowed Oblique Wing Booster

AIRPLANE Aerodynamic Coefficients, M = 4.00

AIRPLANE



S. Cliff/AII

Drag Corrections for Re, Base Drag, and Aspect Ratio

$$CD_{ow\text{-}gb} = CD_{F8} - \Delta CD_{Re} + \Delta CD_{base} + \Delta CD_{AR}$$

Re Correction:

@ H = 42,000 $\Delta CD_{Re} = 0.0045$

@ H = 0 $\Delta CD_{Re} = 0.0037$

Base Drag:

@ M > 1 $\Delta CD_{base} = 0.0185$

@ M < 1 $\Delta CD_{base} = 0.0130$

AR Correction:

@ AR=9.5 $\Delta CD_{AR} = 0.0020$

@ M < 1 $CD_{ow\text{-}gb} = CD_{F8} + 0.01$

Conclusions

- **Oblique Wing Stows on Booster with Minimum Impact on Ascent Configuration**
- **Successful Glide-back Trajectory Demonstrated**
- **Many Issues/Questions Remain** – Tentative answers exist.
  - **Increased Booster Length Improves performance**
  - **Aero-brake from Separation to Apogee**
  - **Base Drag Reduction**
  - **Wing Weight**
  - **Aft C.G. For Liquid Fueled Rocket**